Four Ways of Seeing: Art Looks at Science, and Vice Versa

From the mythmaking of primitive cave painters and the rigorous observations of Renaissance painters sprang the two great ways of seeing the world: science and art. Until modern times, the two were often at odds, as each felt the other was trying to stifle it and dominate the conversation. But as the left and right hemispheres of the brain represent rationality and creativity and cannot function normally without massive interconnectedness, so can science and art only give us a complete picture of our world by working together. This paper will explore various ways in which science and art have interacted.

1. Art Looks at Science

Robert Oppenheimer, the lead scientist on the Manhattan Project and rightly called "the father of the atomic bomb," saw his offspring as a mythic force when he said "now I am become [Shiva], the destroyer of worlds" on witnessing the first test of an atomic bomb in 1945. Over the years, that moment of detonation came to be seen as the low point of science, and people began to turn against science once again after years of celebrating it as either an engine of progress or an expression, like art, of mankind's eternal quest to discover the unknown. Indeed, as World War II became the Cold War, an entire subgenre of art, especially film, sprang up with mutant ants and giant lizards threatening civilization thanks to the madness of science.

But in fact, the view of scientist as madman tinkering with the natural order of things is far older, appearing periodically as science advanced too far beyond the general public's acceptance.

The modern view of scientist as villain probably dates to Mary Shelley's *Frankenstein, or the Modern Prometheus*, an 1818 novel with roots in the Gothic novel and the industrial revolution, written as a morality play and cautionary tale about a scientist tampering with forces beyond the ken of man. It was an immediate popular (if not critical) success, and the 1931 film by James Whale cemented the image of Frankenstein's monster — and his mad scientist creator — in the public imagination. Indeed, a survey of 1,000 horror films distributed in the UK between the 1930s and 1980s revealed that mad scientists or their creations have been the villains of 30 percent of the films, that scientific research had been the cause of 39 percent of the threats, and scientists have been the heroes just 11 percent of the time[1].

A character similar to Dr. Frankenstein appears in H.G. Welles' *The Island of Dr. Moreau* and similar themes appear in such diverse works as Aldous Huxley's *Brave New World* and J.R.R. Tolkien's *The Lord of the Rings*. In each, scientific progress is viewed as negative and wrong, compared to the traditional ways.

This was not always the case. Science has had a long history of inspiring the arts in positive ways as well as negative ways. There are many ways of viewing the transition from the Middle Ages to the Renaissance, but Gardner's *Art Through the Ages* introduces it this way:

> The medieval distinction of *ars* and *scienta* is replaced by a concept (becoming current again) that views them as interrelated. Albrecht Dürer will insist that art without science — that is, technique without a theory relating the artist's skills and observations — is fruitless. The careful observations of the optical world made by Renaissance artists and the integration of these observations by such a mathematical system as perspective [...] foreshadow the formulations of the natural sciences.[2]

Perspective was perhaps the first serious consideration of geometry in the West since the ancient Greeks. It is illustrated in Tommaso Masolino da Panicale's 1425 painting *St. Peter Healing a Cripple and the Raising of Tabitha*, in which parts of the scenery, such as the edges of buildings, show perspective by receding along lines terminating at a vanishing point. But science influenced art, as well, as shown in Rembrandt's 1632 painting *Anatomical Lecture*, which was a meticulous study of men at a medical school studying the human body.

A technological leap almost as significant to art as the Renaissance took place in the late 19th century with the development of motion photography, or cinema. Beginning with Méliès and the Lumière brothers, cinema rapidly became recognized as a new art form, and many painters were influenced by it. For instance, in 1912, Marcel Duchamps' *Nude Descending a Staircase* and Giacomo Balla's *Dynamism of a Dog on a Leash* appeared, both being profoundly influenced by the cinema. The entire futurist movement, too, was at least in part a paean to the rapidly changing world of science and technology, but this aspect of the modernist movement dates back

at least to the building of the Eiffel Tower in 1889, reflected in such works as Robert Delaunay's 1912 painting *The Red Tower* and Vincente Huidobro's 1917 poem "Eiffel Tower."

But the influence of science on the arts was just beginning. People disagree over when the first science fiction work appeared, but most agree that it first began to flourish in the late 19th century with H.G. Welles and Jules Verne. Both were influenced by the rapid advance of science in the 19th century. The same was true of the great expansion of science fiction publishing in the 1930s, with Hugo Gernsback (for whom science fiction's most prestigious award, the Hugo, is named) and the so-called "Golden Age." Science fiction grew again in popularity in the post-World War II era in response to the development of atomic power and the first flights into space. Today, roughly half of the professionally published short fiction in the English language is science fiction.[3] Examples from these eras show how science fiction authors followed the science of their time: In Jules Verne's *From the Earth to the Moon,* the explorers were shot from a giant cannon; by 1947 Arthur C. Clarke was using rockets remarkably similar to what we use today in *The Prelude to Space*.

2. Science Looks at Art

Since the time of Aristotle, philosophers and critics who studied art have attempted to apply rigorous criteria approaching those of the sciences of the time. Modern literary criticism is no different. Among the approaches inspired by science that modern literary critics take are psychoanalytic criticism (Freud's analysis of Shakespeare's *Hamlet* in *The Interpretation of Dreams* led to an entire branch of literary criticism), linguistic analysis (including computerized

authorship verification), anthropology, and sociology. In addition, some critics use science (or attempt scientific credibility) via such approaches as Darwinian literary studies and Reader-Response Criticism.

Science has had a better time with the visual arts, due partly to the fact that commoditization of the *objet d'art* has made preservation and authentication of paintings a high-stakes endeavor. Because of the limited quantity of major *objets d'art* and the insatiable desire of the rich to possess them, forgery is a common problem, and computer scientists recently developed clever algorithms to compare digital copies of paintings to see which is authentic. The television program *Nova ScienceNOW* commissioned a careful forgery of Vincent van Gogh's *The Reaper* as a test for five teams of computer scientists. The painting was made over several weeks by a professional art restorer and was easily good enough to fool the eye, but all five computer analyses successfully caught it. Photo manipulation software and techniques have become so sophisticated that composites can be good enough to fool magazine photo editors. Dartmouth mathematician Hany Farid has developed software to detect fake photos from lighting and digital artifacts that is so good that law enforcement agencies and software giant Adobe (maker of photo editing package Photoshop) have worked with him.

In addition to detecting frauds, scientists assist in the analysis of paintings with X-rays and other scanning techniques, looking below the surface of a painting to see what lies beneath. This can aid restoration or simply teach us about the history of the painting or the painter's technique. For instance, in 2006 French and Canadian researchers used three-dimensional technology including

laser scanning to reveal fine detail in da Vinci's *Mona Lisa* which indicated that the subject, Lisa Gherardini del Giocond, was either pregnant or had recently given birth when she sat for the painting, based on the presence of a very fine gauze veil she was wearing on her dress, an ornament typical for soon-to-be or new mothers at the time, according to Michel Menu, research director of the French museum's Center for Research and Restoration.[4]

Museums use sophisticated scanning and chemical analysis to plan restoration, and computer manipulation to preview the restored work. A 2008 exhibit at the Guggenheim in New York displayed six years of research by them and the Museum of Modern Art into high tech restoration techniques, including lasers. A digital restoration of the Mona *Lisa* by David Claerr in 2007 revealed missing details, including the subject's eyebrows, and detail and realism in the background, confirming contemporary descriptions of the painting.

3. Science as Art

It will come as no surprise to anyone who saw Carl Sagan's *Cosmos* series on television, or who read any of Sagan's books, that his writing rises to the level of art. For instance, in describing our place in the cosmos, he wrote:

> Who are we? What are we? We find that we inhabit an insignificant planet of a hum-drum star lost in a galaxy tucked away in some forgotten corner of a universe in which

> there are far more galaxies than people. [...] We make our world significant by the courage of our questions and by the depth of our answers.[5]

This not only accurately describes what we know of cosmology in a witty way, but the second part encapsulates three millennia of philosophy in a way that is as inspiring as the first part is depressing. Most readers would have no trouble describing the work of Sagan as art, along with Steven Jay Gould's *The Panda's Thumb,* Richard Dawkins' *The Blind Watchmaker,* and many others. Certainly no one who has read Edwin A. Abbott's *Flatland,* an examination of one, two, and three dimensional geometry from the perspective of a square living in the eponymous flat land would call this delightful and thought provoking "mathematical fantasy" anything but art.

But science can become art in other ways, such as the scientist moved by some scientific concept to write a novel based on it. For instance, Arthur C. Clarke's *The Fountains of Paradise* took the 1959 idea of an elevator to space from the Soviet physicist Yuri Artsutanov, fused it with the history and mythology of Sri Lanka, and produced a poignant and poetic novel about the engineer responsible for building it and the stunning future the space elevator would usher in.

Who is to say that there is less truth to be gleaned from Heinar Kipphardt's short play *In the Matter of J. Robert Oppenheimer* than from Kai Bird's thorough biography *American Prometheus*? Science can be art as surely as literature can be history. But can art be science?

4. Art as Science

The Renaissance was, at least in part, about removing the distinction between art and science and foreshadowed modern science. In many ways, Renaissance artists were scientists. The previously noted example of *St. Peter Healing a Cripple* represents scientific observation and science in a more general sense, but Leonardo da Vinci was scientific in a more specific sense, as we understand science today. Indeed, this great artist was also the greatest scientist of his time. As an example of his scientific enterprise, da Vinci's 1487 drawing *Vitruvian Man* is a careful study of the geometricity and symmetry of the human body and was a valuable addition to medical science.

Just as da Vinci merged art and science, modern scientists often do science through art in the form of storytelling. Albert Einstein developed the "equivalence principle" through a "thought experiment." He pictured an elevator in which the occupants have no way of knowing whether they are stationary on the earth's surface, feeling gravity, or in a moving elevator in space, feeling the effects of acceleration. Einstein played out the scenario like a story, without running a single experiment, determining that the two effects were identical. The insight eventually led to his General Theory of Relativity, one of the most successful and closely studied theories in the history of science.

The thought experiment had long been part of the scientist's toolkit, but Einstein made it essential. Other famous thought experiments include Schrödinger's Cat, in which Erwin Schrödinger laid out what he saw as absurd consequences of quantum mechanics. His thought

experiment was little more than a story with the plot turning on the result of an experiment, but it led not just to greater popular understanding of quantum theory but to fierce arguments among scientists and the development of the many worlds theory, among others. Physicist Ernst Mach argued that thought experiments were "a necessary precondition for physical experiment."[6] And the philosopher Martin Cohen said that "much of modern physics is built not upon measurement but on thought experimentation."[7]

But thought experiments do not always occur as an immediate precursor to, or part of, science per se. "What if" stories are an essential subgenre of speculative fiction. Some are historical, such as Philip K. Dick's *The Man in the High Castle*, in which he imagines what would have happened if the Axis powers had defeated the Allies in World War II. Most, however, discuss some scientific idea in just the same way a scientist might perform a thought experiment.

A particularly good example is the presence or absence of alien life, since it is where modern observational astronomy, mathematics, the emerging field of exobiology, and speculative fiction intersect. It has long been the dream of many scientists to detect signs of alien civilizations, a dream shared by science fiction writers, for whom alien civilizations are almost a requirement. And for decades, a concerted effort has been made at the SETI program to detect any sign of them, without success. The lack of evidence for alien civilizations has led some to conclude that such civilizations do not exist, and the argument has expanded from "are there alien civilizations?" to "if they exist, why haven't we found them yet?" Once again, scientists and

authors have used thought experiments to try to evaluate possible answers. More often than not, these have come in the form of fiction.

The *Star Trek* series postulates one hypothesis: that intelligent life is out there, but refuses to interfere in the natural development of our civilization (the "Prime Directive") and won't make contact with us until we make an interstellar voyage of our own. A similar idea is explored in Arthur C. Clarke's *2001: A Space Odyssey*, in which an ancient civilization left the famous black monolith behind as a sentinel, watching but doing nothing until humans were advanced enough to reach the moon and discover it. At the other extreme, some believe that aliens exist and are on the earth in secret, experimenting on humans for nefarious purposes and either hiding the evidence or, as in the television program *The X-Files,* conspiring with the government to cover it up.

Fred Saberhagen uses a more disturbing postulate in his *Berserker* series. Many believe that alien probes may actually be *hostile* — if not to us as life forms, then at least to both us and each other as they compete for resources, and this theme is used as the basis for Saberhagen's fictional universe. The theme is expanded in Gregory Benford's *Across the Sea of Stars,* in which humans fight for resources and survival in a galaxy full of machines. David Brin describes a complex, sophisticated landscape of such probes, with missions as varied as their makers, in his story "Lungfish." In it, the universe is a hostile place and space explorers find evidence of it right in our own back yard. But the story ends with a hopeful note, as it is revealed that the alien wreckage the explorers find was a colonization effort destroyed by another probe to preserve the

existing life on Earth. Brin offers a similar, more metaphorical idea in "The Crystal Spheres," in which he shows stars surrounded by impenetrable barriers which can only be broken from the inside, thus allowing anyone inside to evolve undisturbed until they themselves travel outside the sphere. Brin wrote in the author's notes:

> Sometimes the borderlines between science and fiction seem fuzzy. This has never been more true than in the topic of exobiology or SETI [....] Some hypotheses [...] are too weird even to be included in speculative science papers. The theme behind "The Crystal Spheres" is one such idea. I dared not insert it in my upcoming academic book on SETI, but I did think it made a nice story.[8]

In each of these cases, serious science went into the work and the results were, themselves, a form of science, inasmuch as they posited hypotheses, examined evidence, drew conclusions, and made predictions.

5. Conclusion and Call for Action

No one in a modern society can be considered educated without a grounding in both science and art. Artists should understand science and vice versa. Indeed, many artists have become conversant with science and mathematics in order to use modern photo editing tools, such as Photoshop. And many scientists have become adept at fiction writing and science popularization,

both of which use the tools of the artist. Award-winning scientist and fiction writer Arthur C. Clarke once wrote of bridging the divide between "the two cultures" of science and art, but later repudiated that, saying,

> I don't believe there are two cultures; there is only culture and nonculture. A person who knows all about the plays of Aristophanes and nothing about the Second Law of Thermodynamics is as uncultured as one who has mastered quantum theory, but thinks van Gogh painted the roof of the Sistine Chapel.[9]

Governments, educational institutions, and parents need to be less short-sighted and realize that only by emphasizing both the arts and the sciences can schools graduate students who are adequately educated. We should emphasize at every step the creative and critical thinking skills that are common to all academic pursuits, but are too often ignored or practiced in isolation. In doing so, we may even discover that the tools of the artist are more valuable to the scientist that the tools of the scientist are to artists.

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[1] Christopher Frayling, *New Scientist*, 24 September 2005

[2] de la Croix, Horst, and Richard G. Tansey, *Gardner's Art Through the Ages*, p. 527. New York: Harcourt Brace Jovanovich, 1986.

[3] Brin, David. "Author's Notes [to "The Crystal Spheres"]," in *The River of Time*. New York: Bantam Books, 1994.

[4] "Was Mona Lisa Pregnant?," The Associated Press, 27 September 2006. See http://www.cbsnews.com/stories/2006/09/27/world/main2043887.shtml

[5] Sagan, Carl. *Cosmos*. New York: Random House, 1980.

[6] ibid

[7] Martin Cohen, *Wittgenstein's Beetle and Other Classic Thought Experiments* Oxford: Blackwell, 2005.

[8] Brin, op. cit.

[9] Clarke, Arthur C. "Science and Science Fiction," in *Time Probe: The Sciences in Science Fiction.* New York: Dell Publishing, 1966.